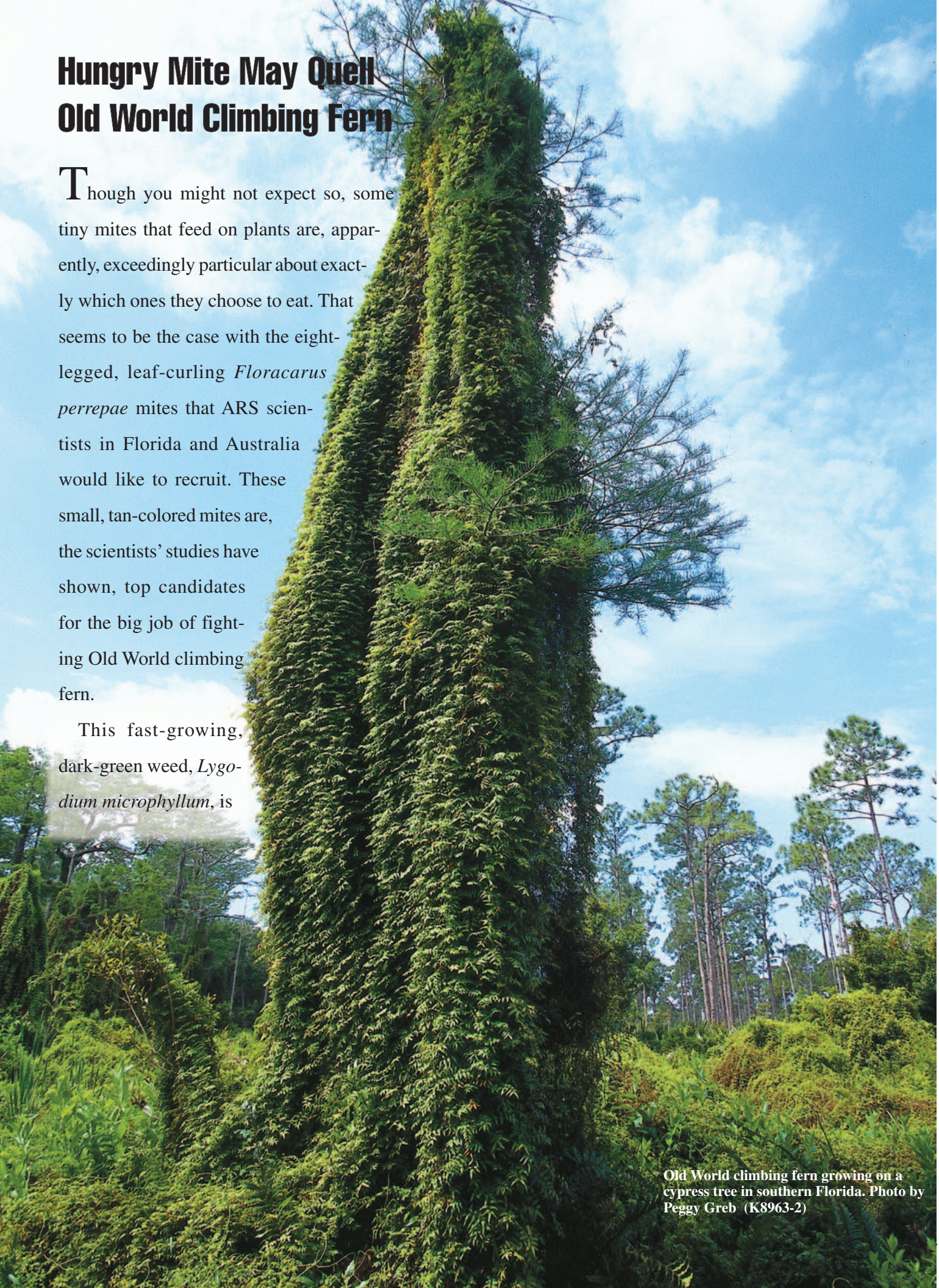
Hungry Mite May Quell Old World Climbing Fern

Though you might not expect so, some tiny mites that feed on plants are, apparently, exceedingly particular about exactly which ones they choose to eat. That seems to be the case with the eight-legged, leaf-curling *Floracarus perrepae* mites that ARS scientists in Florida and Australia would like to recruit. These small, tan-colored mites are, the scientists' studies have shown, top candidates for the big job of fighting Old World climbing fern.

This fast-growing, dark-green weed, *Lygodium microphyllum*, is



Old World climbing fern growing on a cypress tree in southern Florida. Photo by Peggy Greb (K8963-2)

on the march in Florida's unique and fragile Everglades ecosystem and other wetlands. In fact, climbing fern is spreading so rapidly that it's now the state's worst invasive weed.

First detected growing outdoors as an "escaped ornamental" in 1965, the fern now infests more than 100,000 acres in the Sunshine State.

Old World climbing fern smothers native plants by forming dense mats along the ground and by extending—vine-like—up shrub stems and tree trunks, forming massive green walls of vegetation. These curtains greatly increase fire danger by providing a flammable ladder stretching from ground to canopy. Making matters worse, fern leaves, called fronds, that catch fire often break off and sail away on the fire's updrafts, serving like torches to spread the blaze even further.

A Mite-y Adversary?

The *F. perrepae* mite acts as a natural enemy of the fern. That's why ARS entomologists John A. Goolsby at the agency's Australian Biological Control Laboratory at Indooroopilly, near Brisbane, and Robert W. Pemberton of the ARS Invasive Plant Research Laboratory, Fort Lauderdale, Florida, want to put the mite to work in Florida's fern-ridden wetlands.

(K8965-1)

Entomologist John Goolsby inspects Old World climbing fern in its native habitat in Queensland, Australia.

The chances for their strategy to succeed have been greatly improved by the recent discovery of mite populations that may be a perfect match for the particular kind of climbing fern that is choking vegetation in Florida. Not all *F. perrepae* mites will feed on and make a home in the Florida fern, the scientists have learned.

"But we think we've found what, so far, is the right mite for the right fern," Goolsby points out.

Matchmaking Makes a Difference

The quest for the perfect pairing of mite and fern was spurred by Goolsby and cohorts' finding that *F. perrepae* mites collected in some regions of Australia wouldn't feed and reproduce on climbing fern collected from other locales, such as Florida.

The scientists combed climbing fern's native range, hunting for the plant and the critters that keep it in check in rainforests, dry seeps, coastal marshes, bay swamps, and tree islands. These treks took them to more than a dozen nations and territories, including Benin, China, Ghana, India, Indonesia, Malaysia, New Caledonia, Papua New Guinea, Singapore, South Africa, Sri Lanka, Thailand, and Vietnam, scouting more than 100 different sites. These exotic venues not only presented a significantly good chance of harboring important natural enemies of climbing fern, but were also home to adversaries of the scientists—including disgruntled elephants, fierce tigers, hungry crocodiles, and an array of poisonous snakes.

Goolsby and teammates from Australia's Commonwealth Scientific and Industrial Research Organization made

Microscopic Look at Mite Mouthparts

It's already known that when mites successfully attack fern plants, fronds form tight curls that provide perfect food and housing for the little attackers.

But the mystery of why mites of certain genotypes attack certain Old World climbing fern genotypes—but not others—remains unsolved. Scientists have recently ruled out the possibility that the stylets of certain mites are too short to puncture cells on the front surfaces of some ferns.

Thomas Freeman of North Dakota State University, Fargo, used scanning electron microscopy to determine that mite stylets are 10 micrometers long, certainly long enough to penetrate frond surface cells, which he showed are only 1 or 2 micrometers thick.

"Now that we know some mechanical problem isn't the barrier faced by certain mites," says ARS entomologist John A. Goolsby, "we think an unknown interaction between chemicals in the mite and in ferns is an underlying factor in some mites' success."—By **Marcia Wood**, ARS.

THOMAS P. FREEMAN (K11273-1)

***Floracarus perrepae* mite, a top candidate for fighting Old World climbing fern. Magnification about 1800x.**

it home unscathed—with a key discovery, too: They are the first to separate climbing fern into genetically distinct local races, or genotypes. "By comparing fern genetic material, we learned that the fern occurs in different genetic forms," says Goolsby. "We looked at the same stretch of DNA—a region known as trnF through trnL—in climbing ferns, and found an exact genetic match to the Florida genotype. It was growing alongside a stream in the Cape York area, a rugged, remote part of northern Australia where the fern wasn't previously known to exist.

"And a fern we collected in a rainforest in Thailand is nearly an exact match."

Miniature Fern Grotto Hastens Search

To speed the search for mites that were in sync with the Florida genotype, Goolsby developed the tactic of taking small plantlets, or sporelings, of the Florida variant along on expeditions so that local mites could be immediately exposed to this target plant within the confines of a mobile laboratory. (Of course, taking the miniature fern forest into foreign countries was done only with approval from the host nations.) This cafeteria-on-wheels approach to screening mites saved weeks of time that might otherwise have been spent on mites that don't favor the Florida fern.

Not surprisingly, the *F. perrepae* mites that Goolsby and colleagues plucked from the Cape York and Thailand ferns are today the best prospects for clobbering climbing fern in Florida.

In tests with climbing ferns grown in garden plots at the Indooroopilly laboratory for 24 months, *F. perrepae* mites were able to blunt growth of fern fronds, stems, roots, and other plant parts by half, in contrast to ferns kept mite-free with a miticide.

Goolsby and colleagues are the first to discover the potential of *F. perrepae* as a natural foe of climbing fern. The Indooroopilly team is now rearing millions of mites indoors, awaiting approvals necessary before the mites can be exported to the United States and released outdoors.

To make sure the mite will attack just climbing fern but not fern relatives, crop plants, or trees and flowers in someone's backyard, the Indooroopilly researchers tested it with more than a dozen plants, including fern relatives from Cuba and other parts of the Caribbean and South America. Florida's proximity to those parts of the world makes this aspect of the mite's background check especially important.

Mites' Meals Balance Ecosystem

Mites damage ferns by puncturing the edges of fern fronds with their tube-like stylets and other mouthparts, sucking up the nutritious contents of frond cells. If the mite attack is successful, in about 3 days the fern leaf will curl downward and inward, rolling over itself two or three times. This reduces the amount of leaf space available to capture light, which the plant needs to make its food. Eventually, the afflicted frond tissue dries up and falls off. Until that happens, however, the swollen, curled edge makes a cozy shelter for the mites. There, they can feed, lay their eggs, and hide from their enemies. As many as 20 adults can crowd into a curl. And there's enough room for female mites to fit hundreds of their little eggs into this refuge.

When the injured leaf edge falls off, the adults merely migrate to another frond, beginning the cycle again. Notes Goolsby, "In the fern's native range, this damage is both subtle and significant. It causes the plant to grow slowly and to stay in balance with other plants."

As much as the researchers have learned, there's still a piece missing in the puzzle. "We had tools of modern biotechnology to help us differentiate the look-alike fern genotypes," Goolsby says, "but we still don't know how mites tell the difference." (See box, page 13.)

PEGGY GREB (K8963-15)

Among cypress trees in southern Florida, entomologist Robert Pemberton examines invasive Old World climbing fern engulfing trees and shrubs.

Larvae of the *Austromusotima camptozonale* moth, formerly known as *Cataclysta camptozonale,* feed on leaves of climbing fern, weakening the plant.

Coming to America?

In Florida, the mite may eventually be joined by two other natural enemies of climbing fern. They are small moths, each no more than a half-inch from wingtip to wingtip. In their caterpillar stage, they feed on fern fronds.

Austromusotima camptozonale, collected from climbing fern in Australia, is bright white with a few black and brown spots and stripes on its wings. *Neomusotima conspurcatalis*, from Australia, India, Malaysia, and Thailand, has dark-brown wings, edged in white and dotted with white, boomerang-shaped flecks.

Perhaps this trio of Old World climbing fern's natural enemies can turn the tide against this pernicious Everglades invader.—By **Marcia Wood,** ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at www.nps.ars.usda.gov.

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